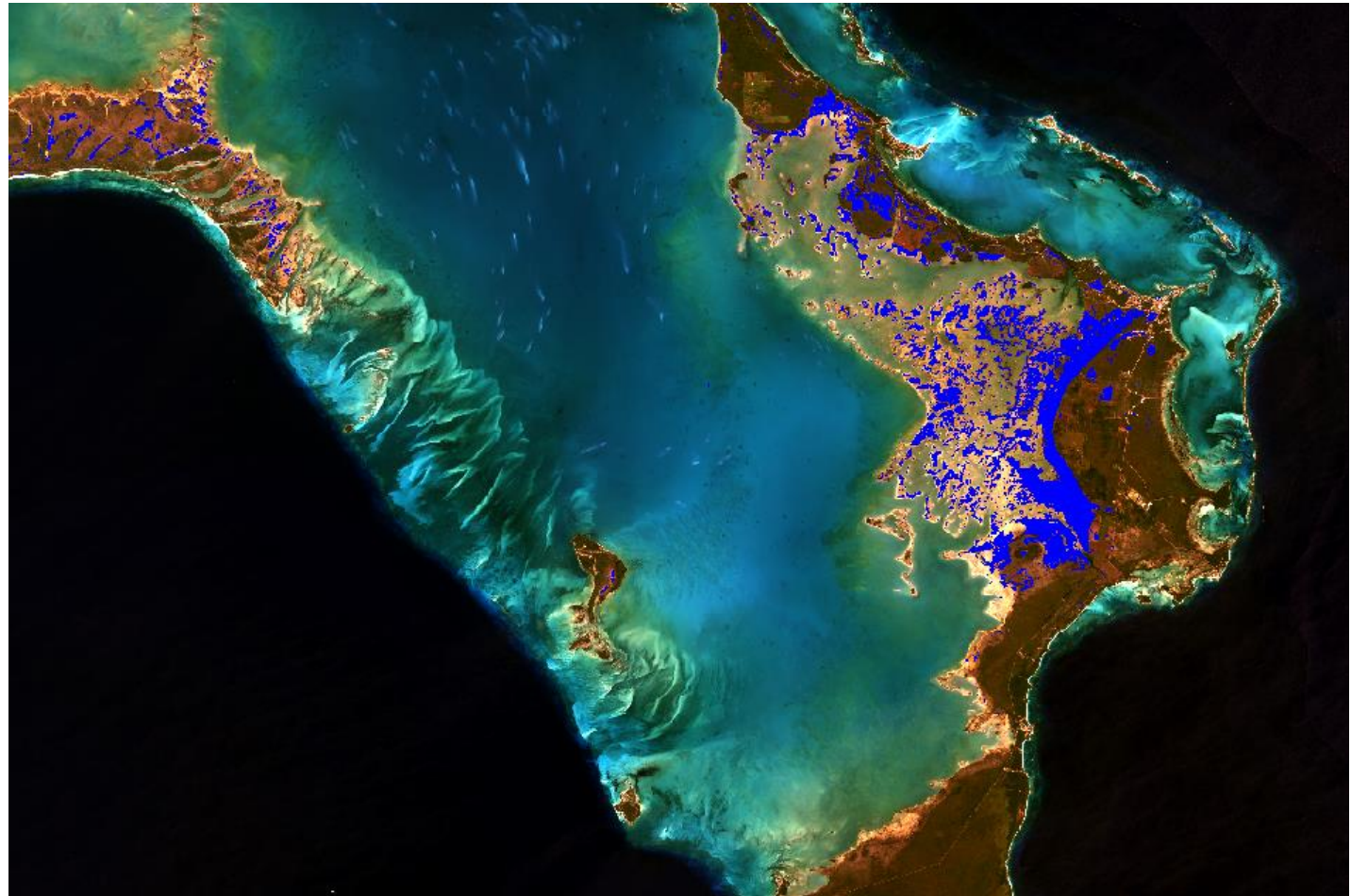


Master SAR

Megan Gallagher

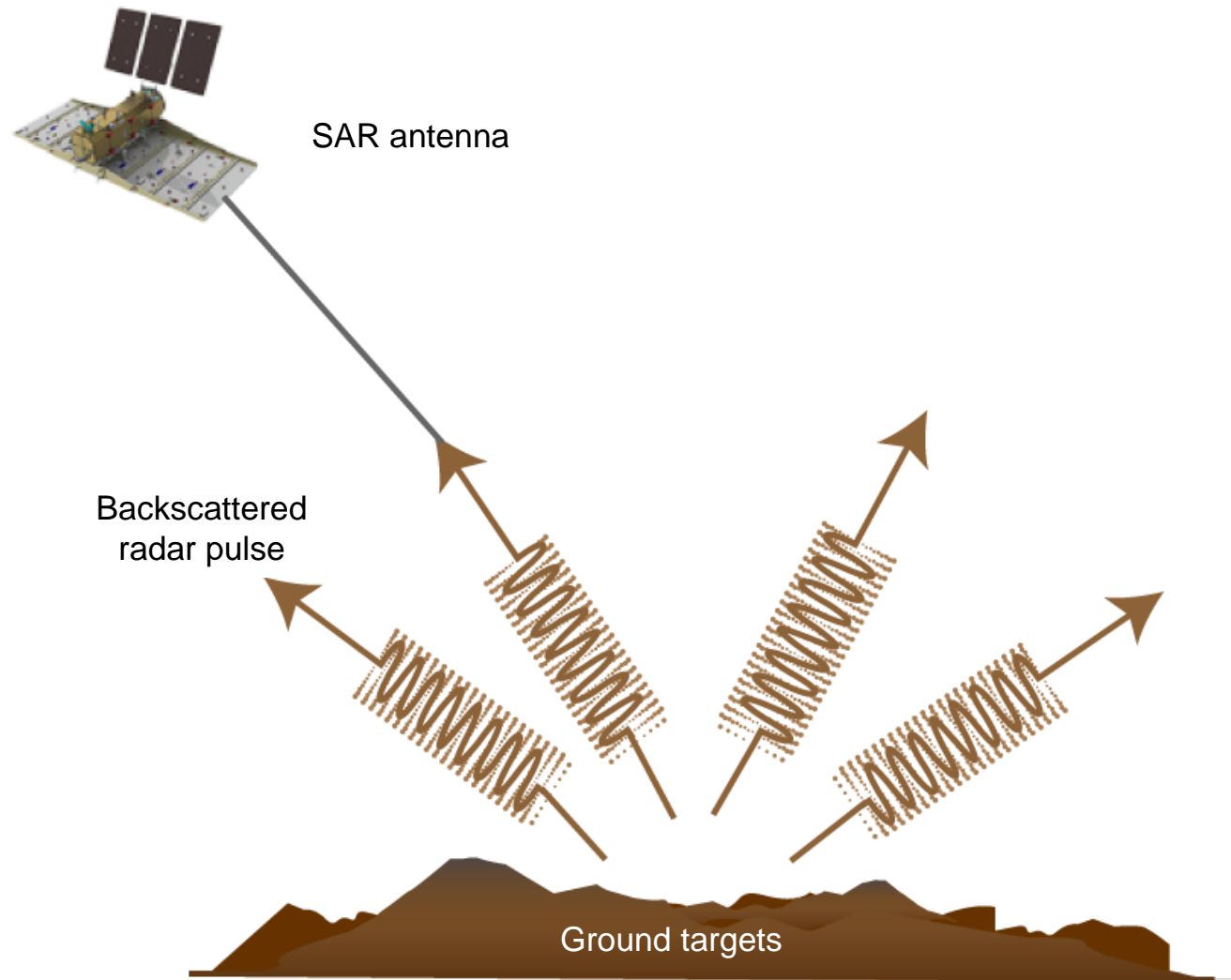
Solutions Engineer, L3Harris Geospatial

Megan.Gallagher@L3Harris.com

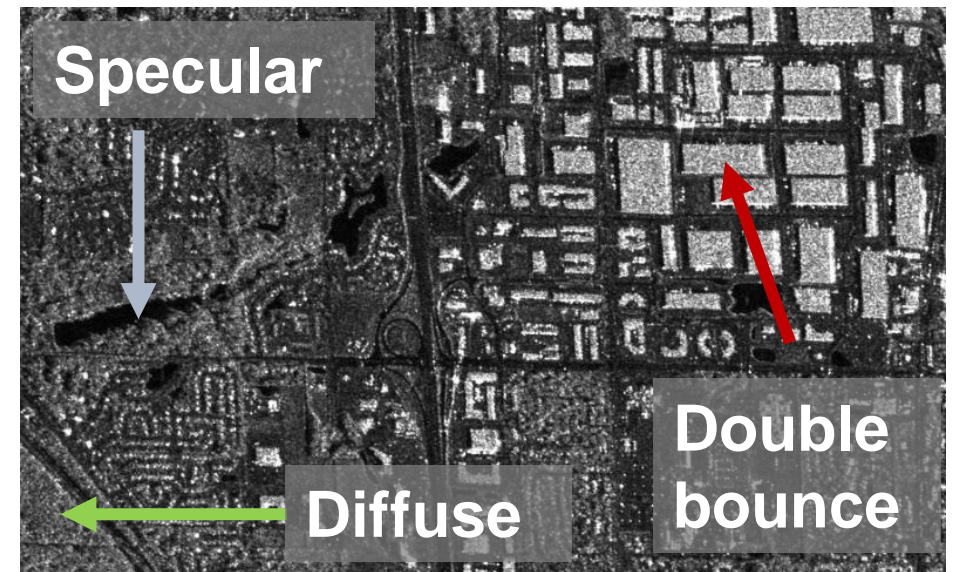
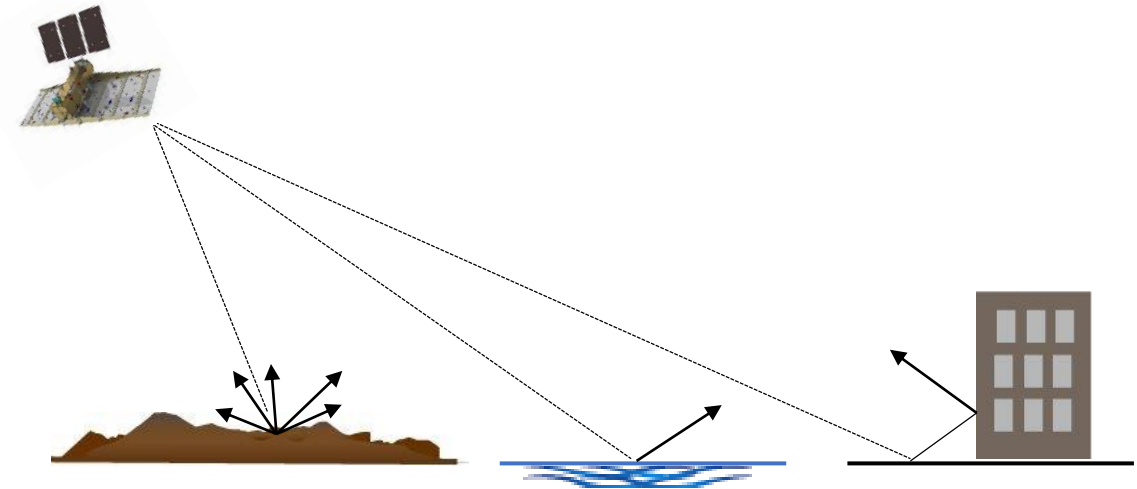
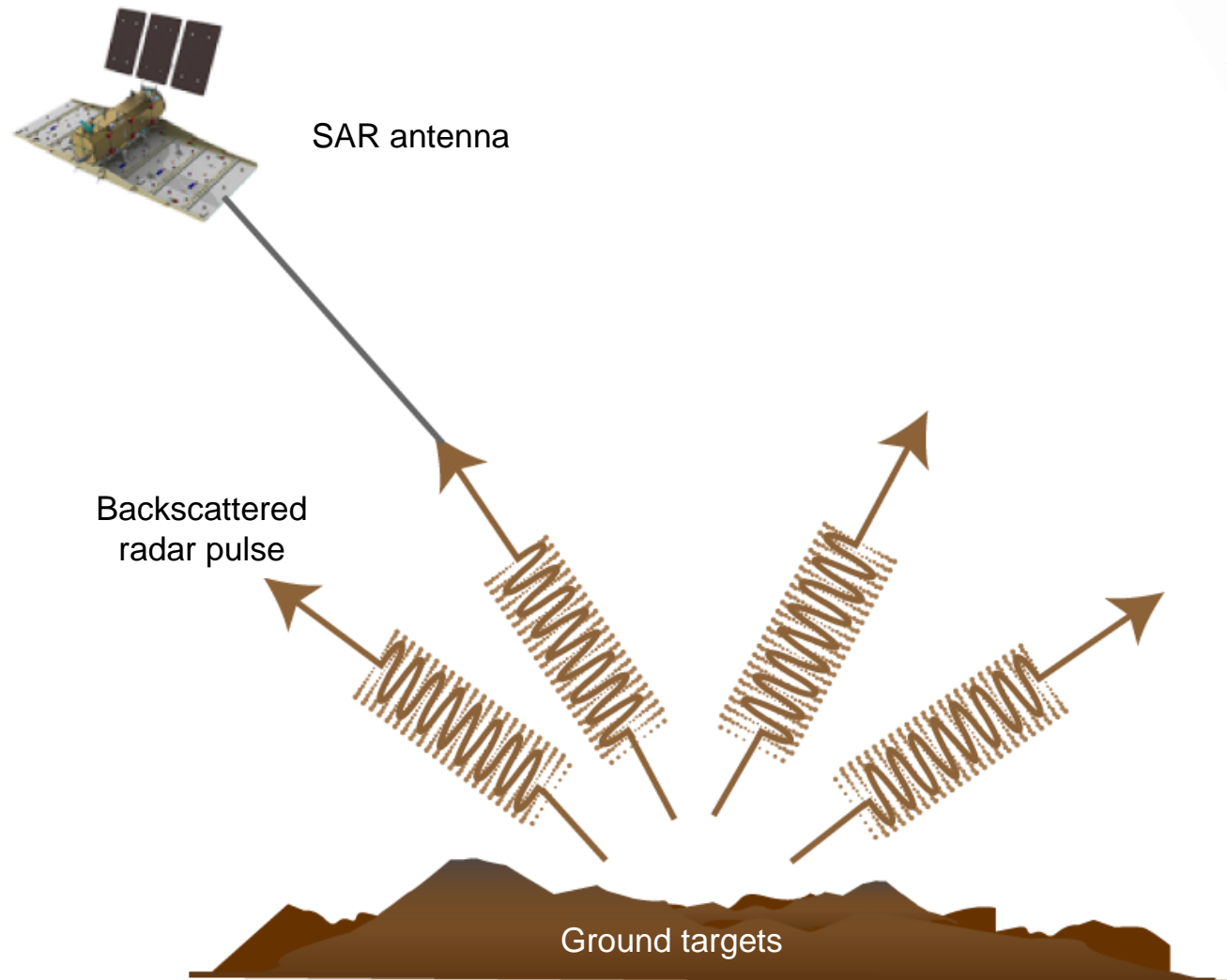


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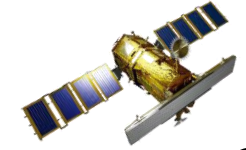
What is Synthetic Aperture Radar?



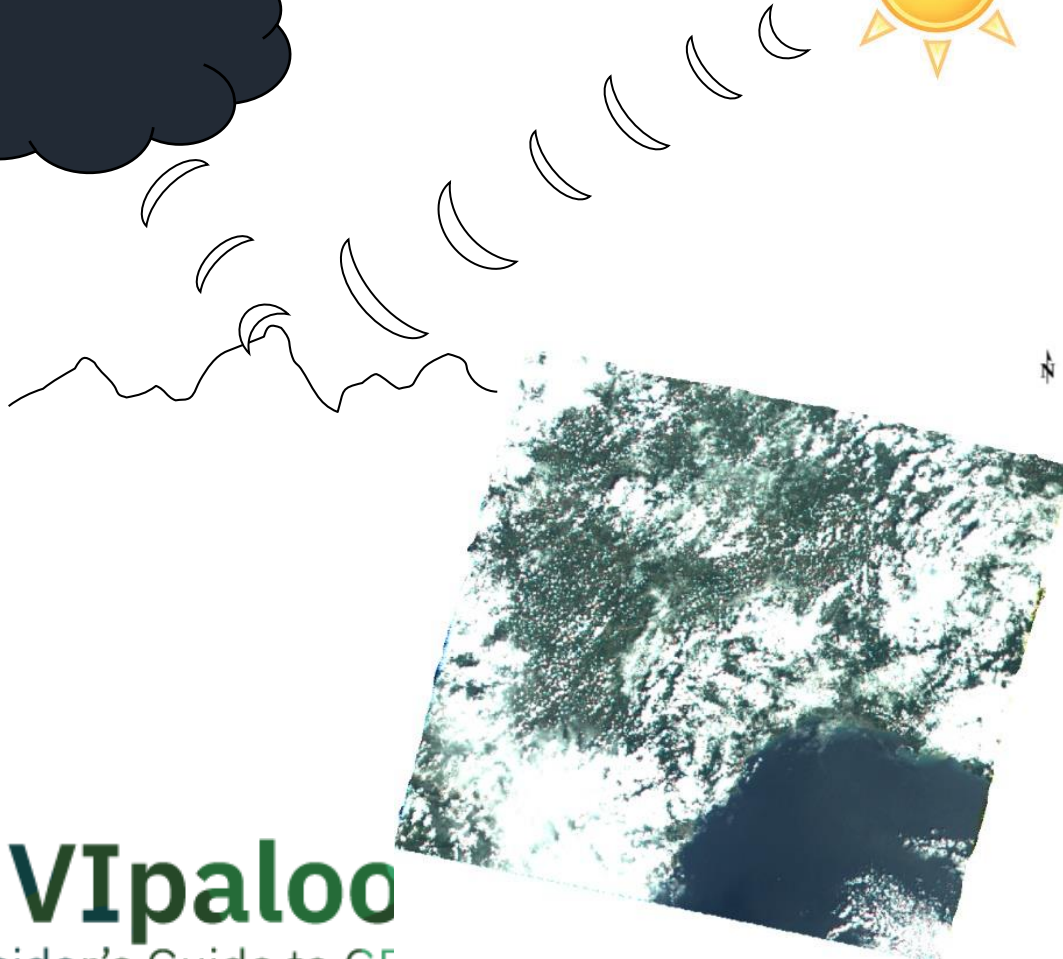
What is Synthetic Aperture Radar?



Why SAR?



Optical: Visible to Infrared



SAR: Active Microwave



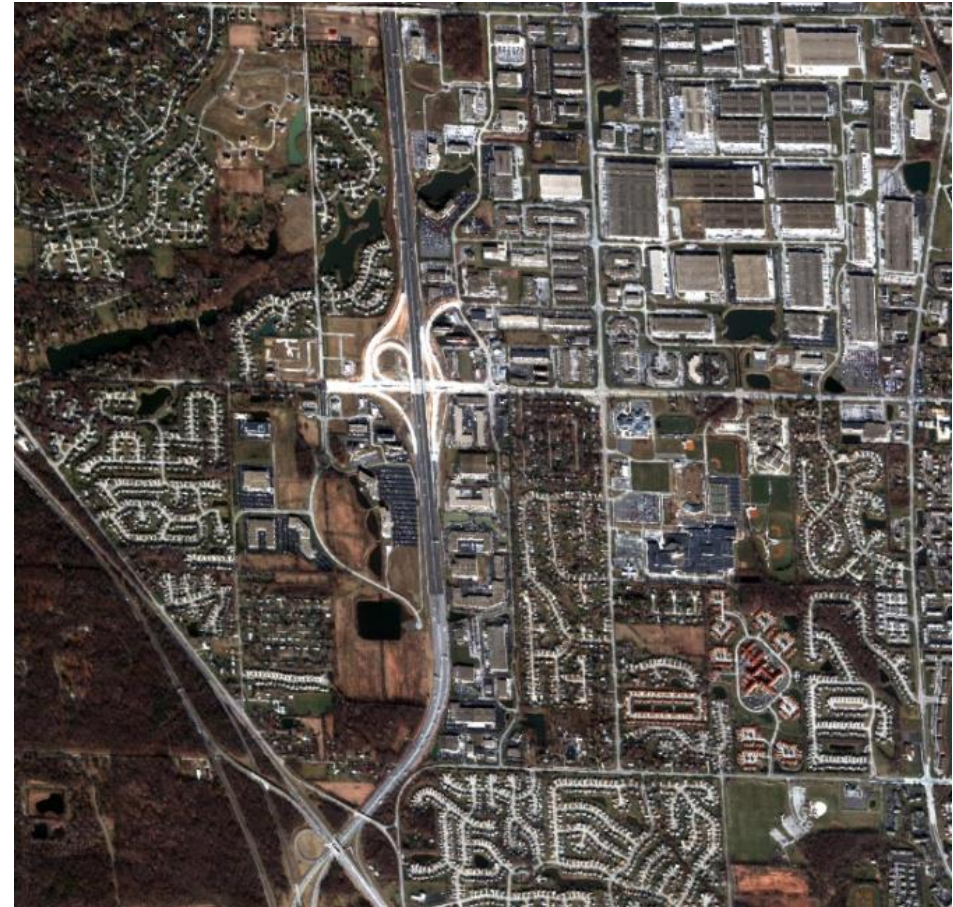
Optical vs. SAR



TerraSAR-X -Indianapolis

07/01/ 2007

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QuickBird - Indianapolis

07/01/ 2007

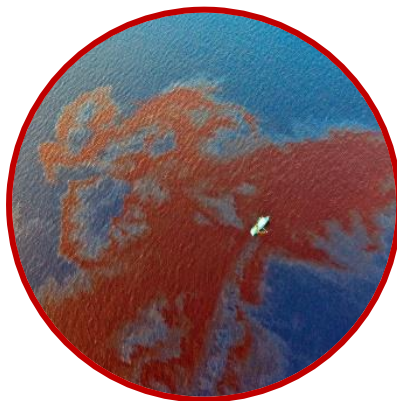
Synthetic Aperture Radar Applications



Landslides



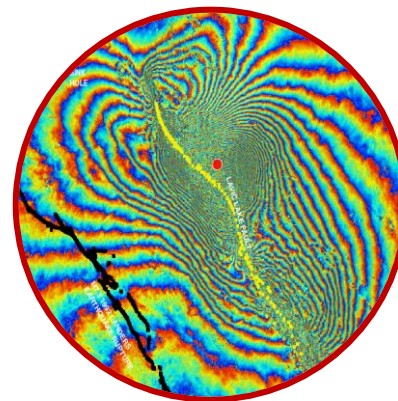
Glaciers and
permafrost



Oil spills



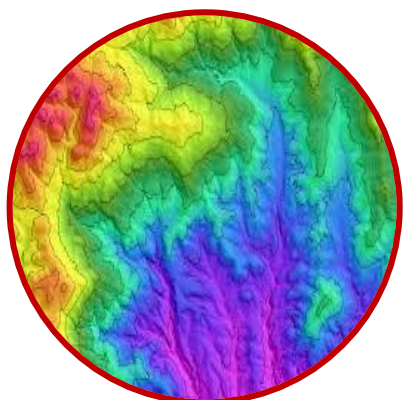
Subsidence



Earthquakes



Shipping



DEM generation



Biomass



Deforestation



Flooding



Volcano
monitoring



Activity
monitoring

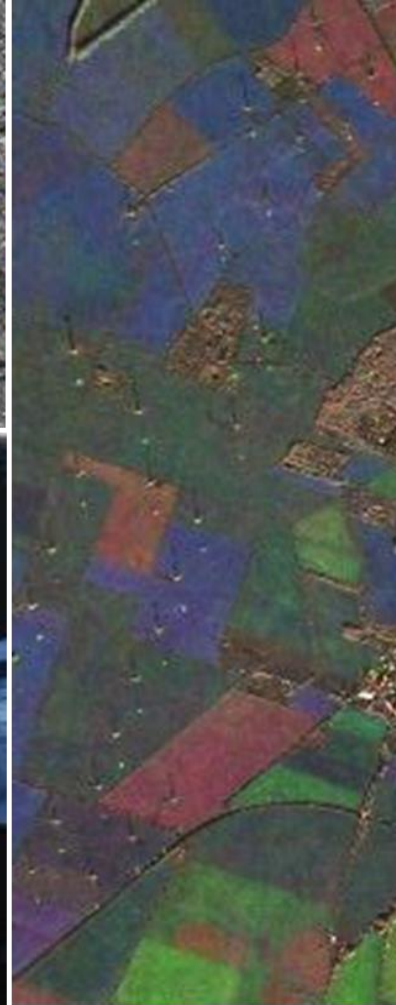
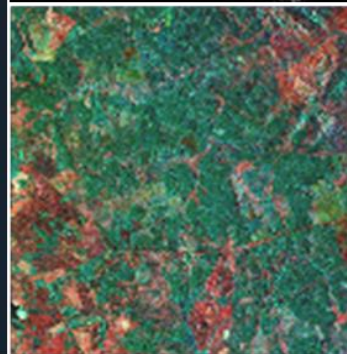
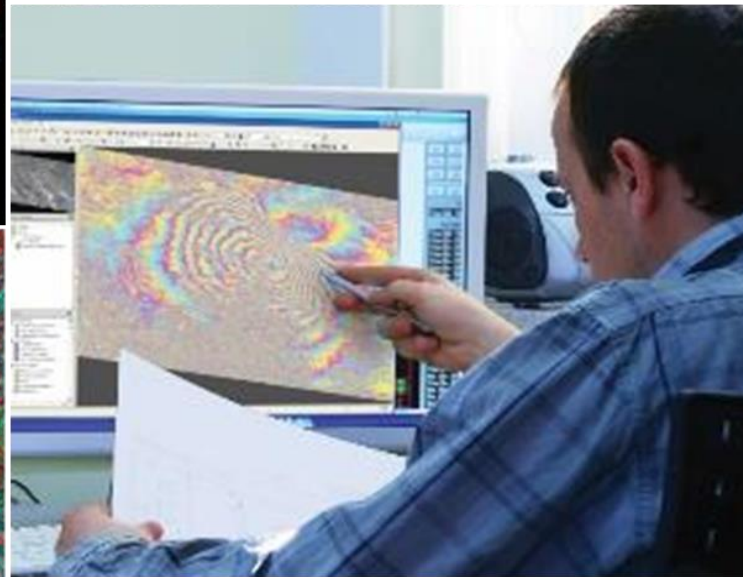
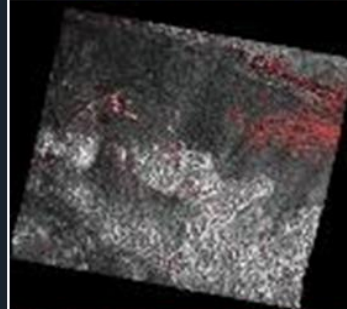
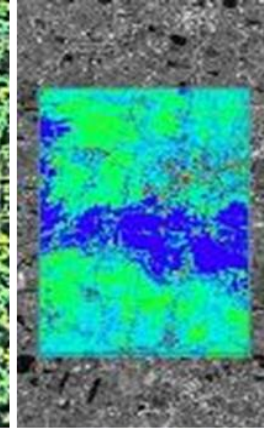
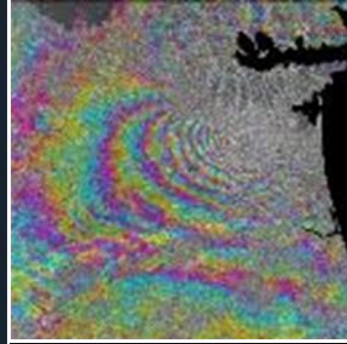
ENVI SARscape

Easily process and analyze SAR data

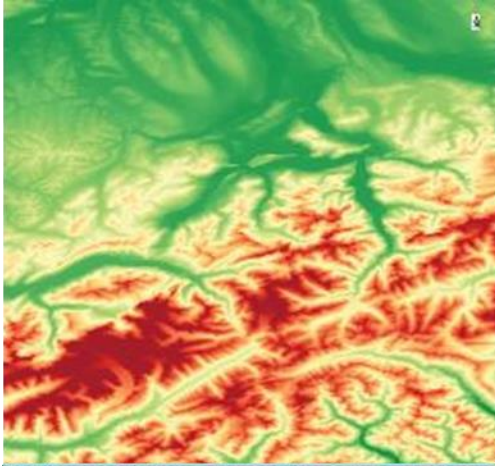
Easily process and analyze SAR data and generate products like DEMs or surface deformation maps

Built-in workflows and modules simplify processing and can be customized

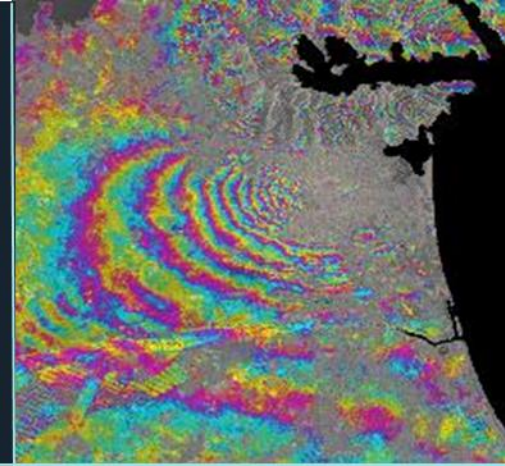
ENVI integration brings advanced image and SAR processing and analysis together in one package



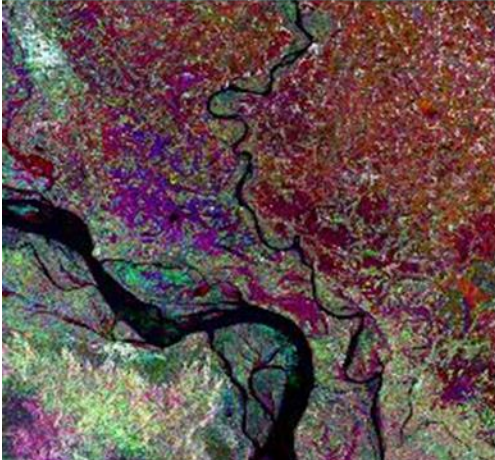
ENVI SARscape Analytics



Perform common SAR processing applications regardless of skill level



Easily process and analyze SAR data and generate products like DEMs or surface deformation maps

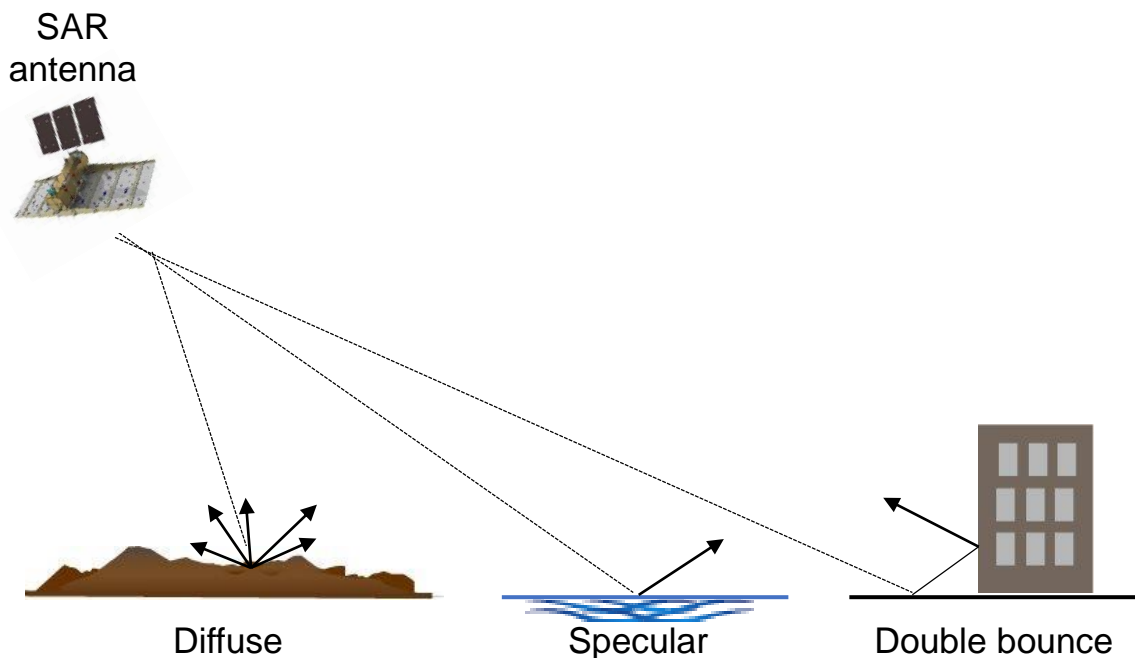


ENVI integration brings advanced image and SAR processing and analysis together in one package

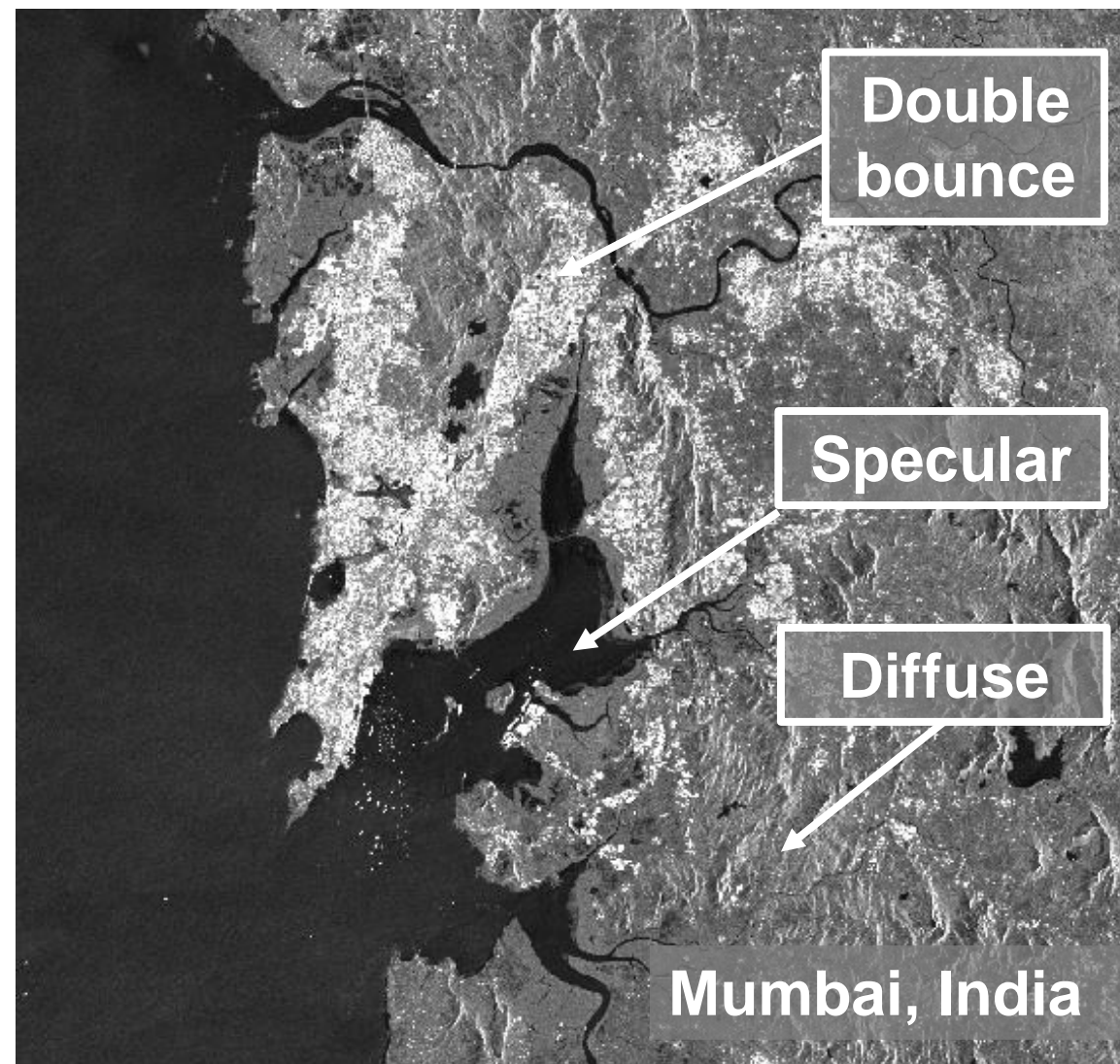
- Flood mapping
- DEM extraction
- Sentinel download
- Sentinel auxiliary file download
- Time series
- Change detection
- Displacement map
- Ship detection
- Persistent scatterers
- Image geocoding

Ship Detection

Differences in radar backscatter highlight ships against water

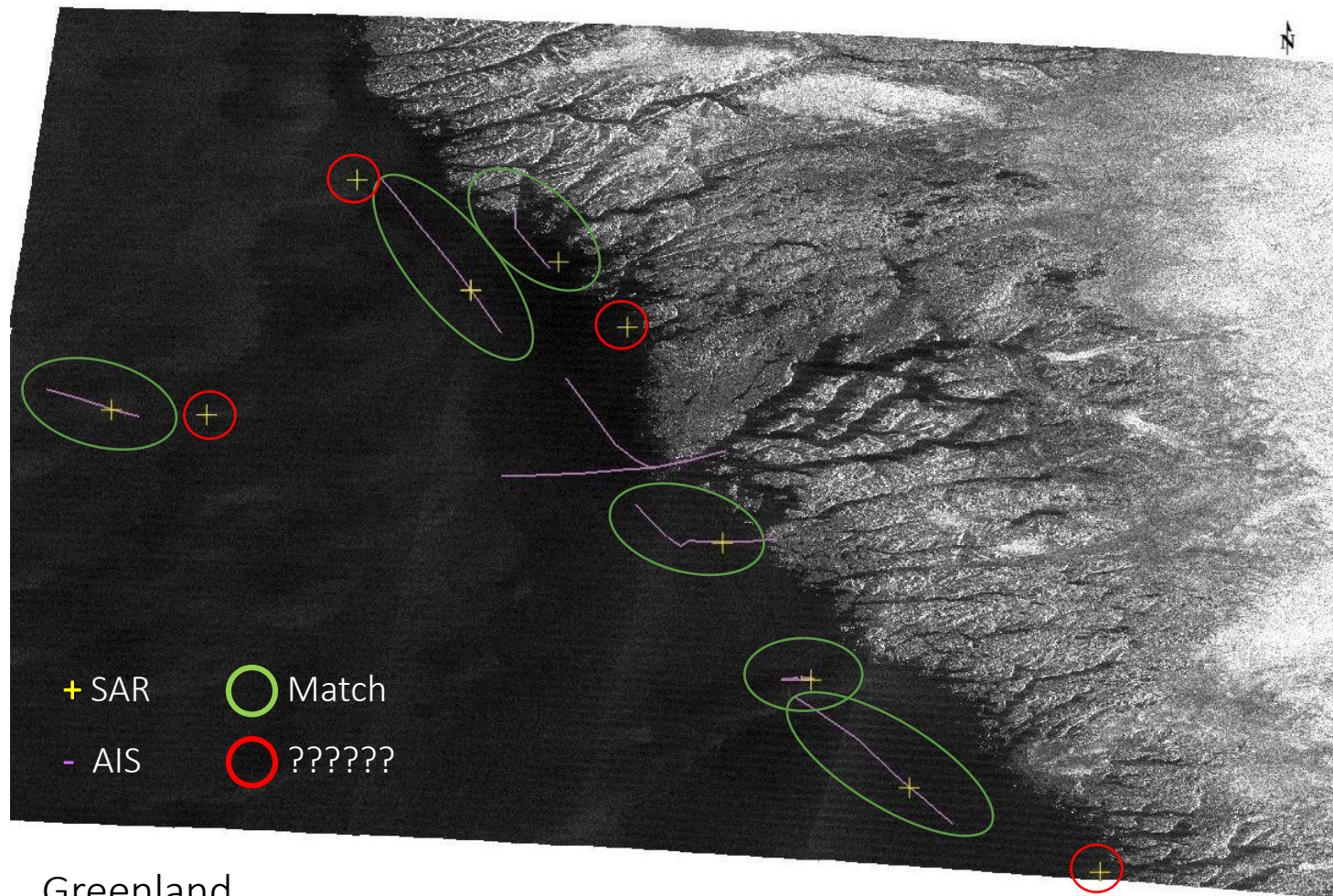
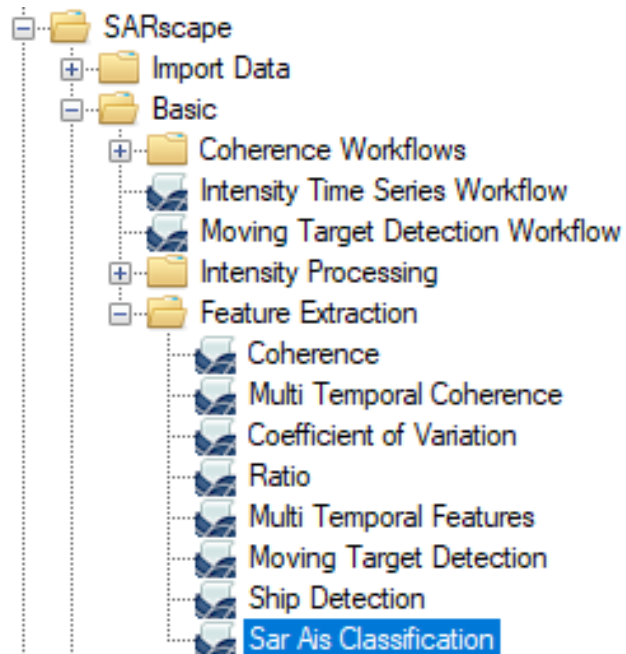


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Ship Detection with AIS

AIS (Automatic Identification Systems) documentation for ships can be used with the ship detection tool

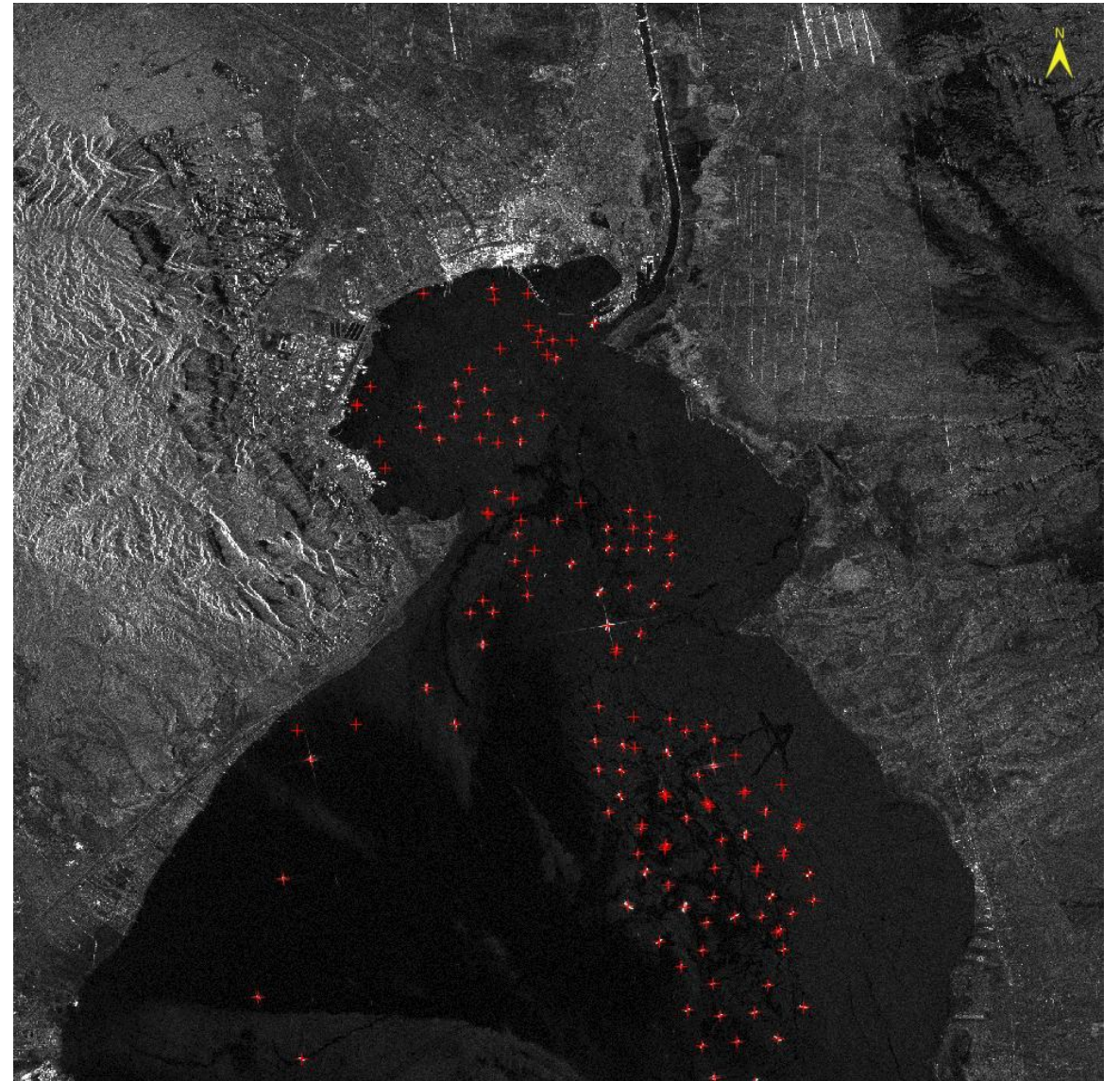


Greenland
Radarsat-2 data
SAR & AIS matching

The Ever Given Blockage



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151 ships detected from Sentinel-1 data

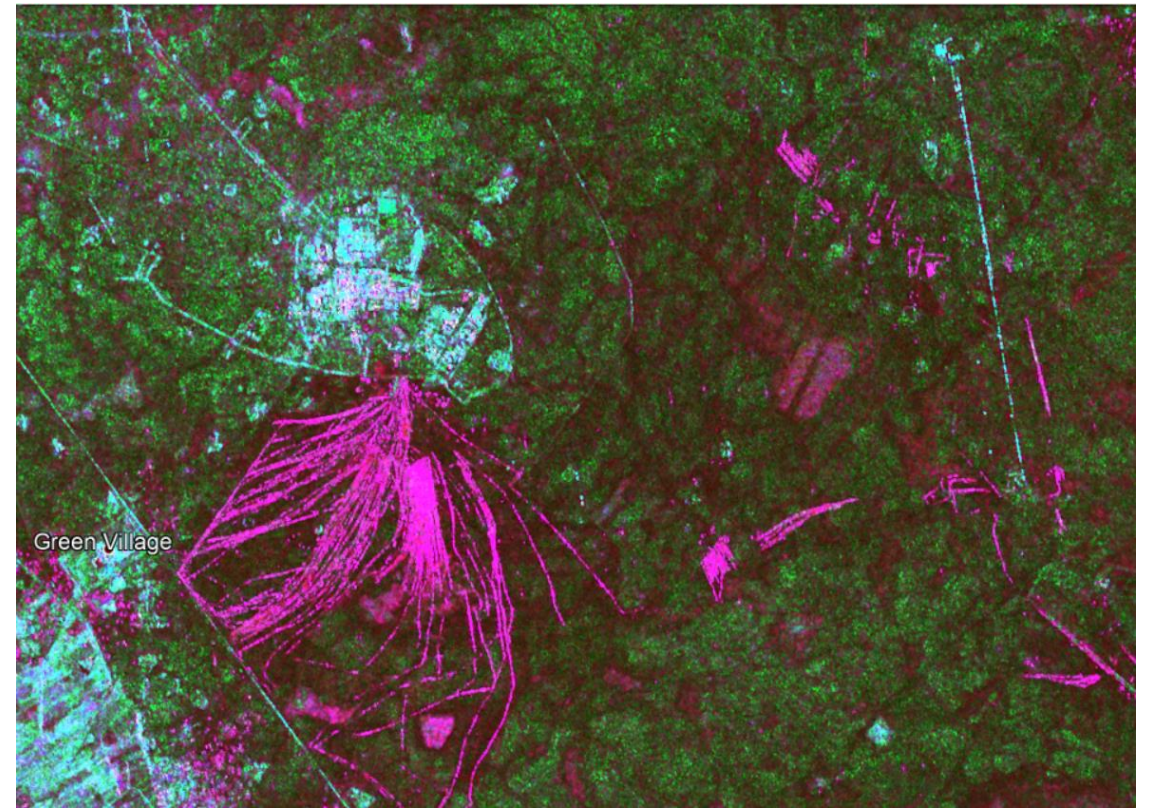
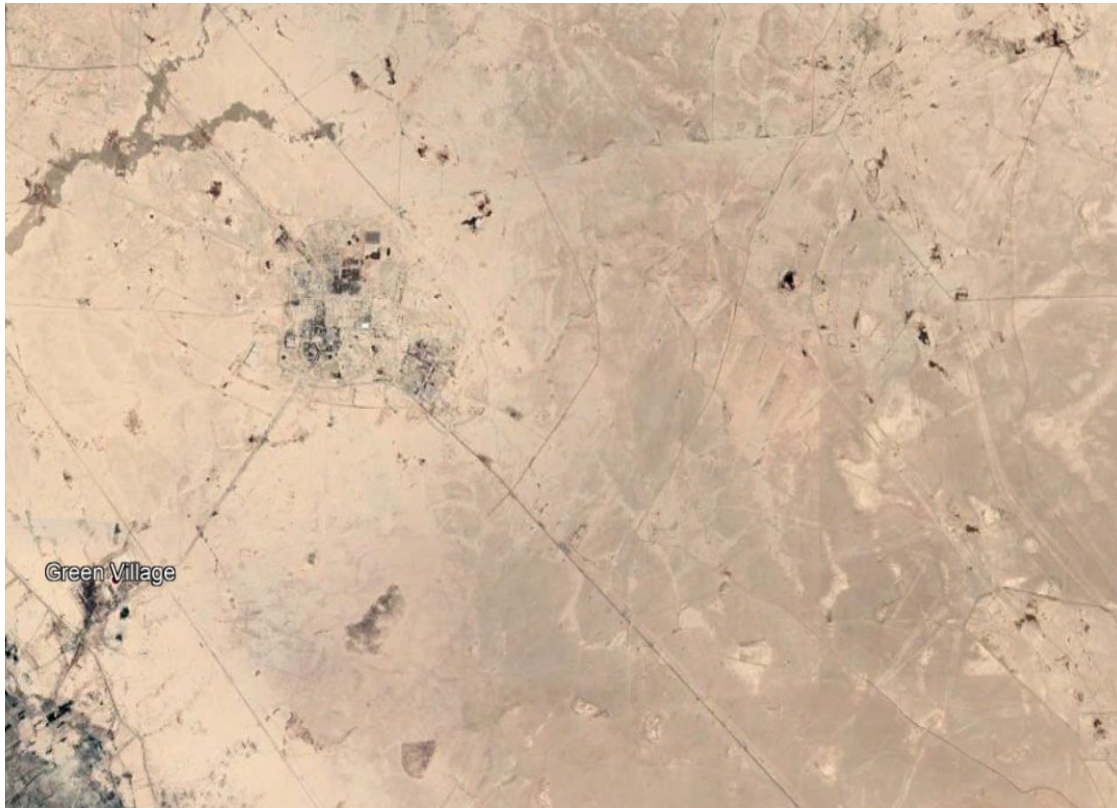
25th March 2021

Coherence Change Detection

The image displays a sequence of five screenshots of the SARscape Workflow interface, illustrating the steps for Coherence Change Detection. Red arrows indicate the flow from one step to the next.

- Step 1: Import Generic SAR Data**
 - Workflow: Import Generic SAR Data
 - Principal Parameters:
 - SENTINEL Area of Interest in Geographic Coordinates
 - SENTINEL Make mosaic same track: True
 - SENTINEL Make power QL: True
 - Apply calibration constant: False
- Step 2: Multitemporal Coherence**
 - Workflow: Multitemporal Coherence
 - Principal Parameters:
 - Range Looks: 4
 - Azimuth Looks: 1
 - Grid Size for Suggested Looks: 15
 - Max Baseline [m]: 50
 - Min Temporal Baseline [days]: -100
 - Max Temporal Baseline [days]: 100
 - Method Selection: Coherence Time Line
 - Coregistration With DEM: True
- Step 3: Sample Selection SAR Geometry Data**
 - Workflow: Sample Selection SAR Geometry Data
 - Principal Parameters:
 - Input Reference File
 - Make Coregistration: False
 - Coregistration With DEM: True
 - Geographical Region: SELECT...
 - West / First Column: -9999
 - North / First Row: -9999
 - East / Last Column: -9999
 - South / Last Row: -9999
 - Use Min and Max Coordinates: False
- Step 4: Coherence geocoding**
 - Workflow: Coherence geocoding
 - Principal Parameters:
 - X Grid Size: 15
 - Y Grid Size: 15
 - Radiometric Calibration: True
 - Scattering Area: Local Incidence Angle
 - Radiometric Normalization: True
 - Normalization Method: Cosine Correction
 - Local Incidence Angle: False
 - Layover / Shadow: False
 - Additional Original Geometry: False
 - Output type: Linear
- Step 5: Generate Color Composite**
 - Workflow: Generate Color Composite
 - Principal Parameters:
 - Operation Type: SELECT...
 - Red Scale: 1
 - Green Scale: 1
 - Blue Scale: 1
 - Red Exponent: 1
 - Green Exponent: 1
 - Blue Exponent: 1
 - Use Red Entered Values Only: False
 - Use Green Entered Values Only: False
 - Use Blue Entered Values Only: False
 - Red Negative: False
 - Green Negative: False
 - Blue Negative: False
 - Only RGB Generation: False
 - White Dummy: False
 - Common Scaling: False

SAR Change Detection



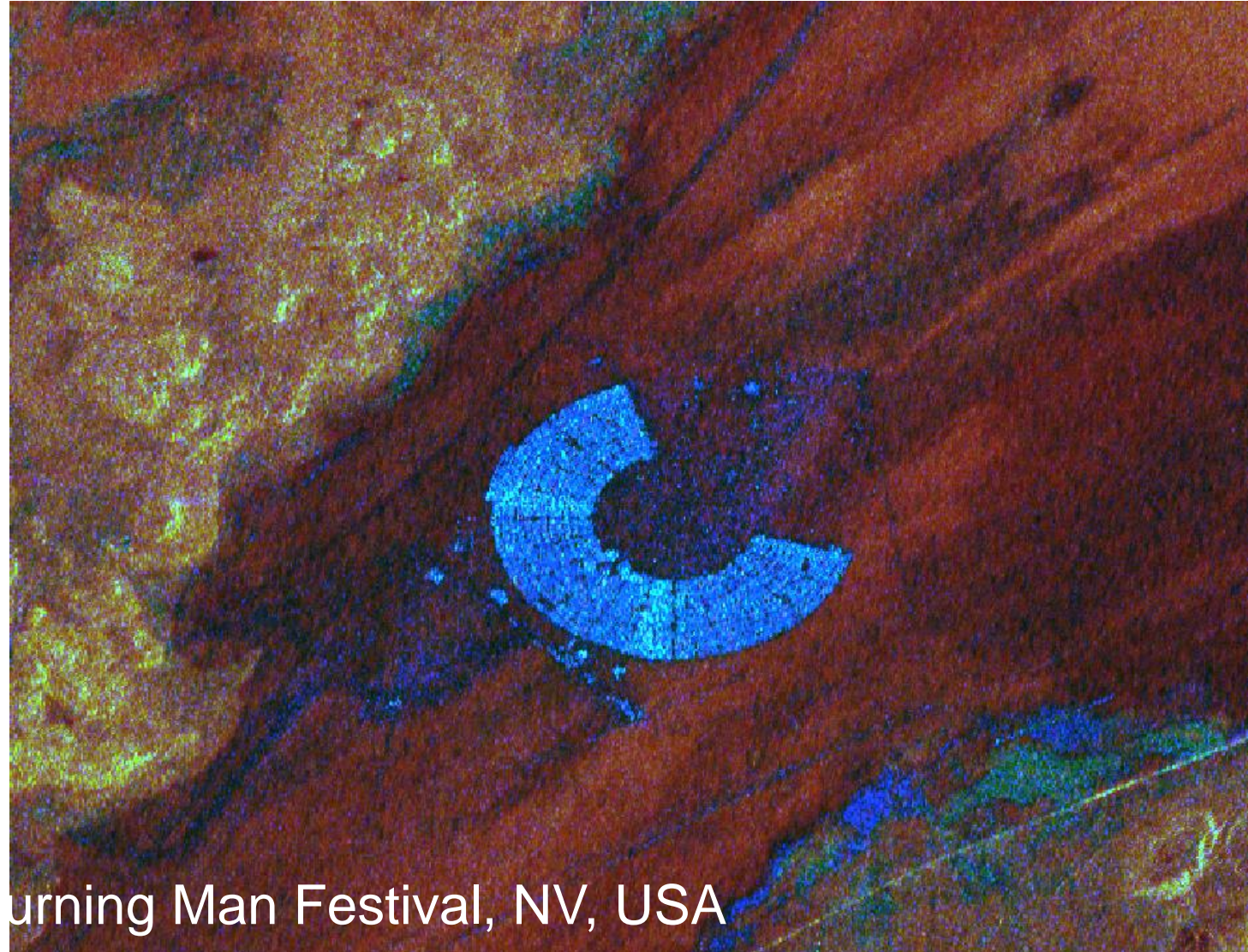
Activity Monitoring: Change Detection

Coherent change detection over
Burning Man Festival
Black Rock Desert, NV, USA

R: Coherence

G: Average backscatter

B: Difference in backscatter
between pre (2018-06-08) and
during (2018-08-31)



Clipboard: Cut, Copy, Paste, Copy Path

Navigate: Explore, Bookmarks, Go To XY

Layer: Basemap, Add Data, Add Preset

Selection: Select, Select By Attributes, Select By Location, Clear

Inquiry: Infographics, Measure, Locate

Labeling: Pause, View Unplaced, More, Convert To Annotation

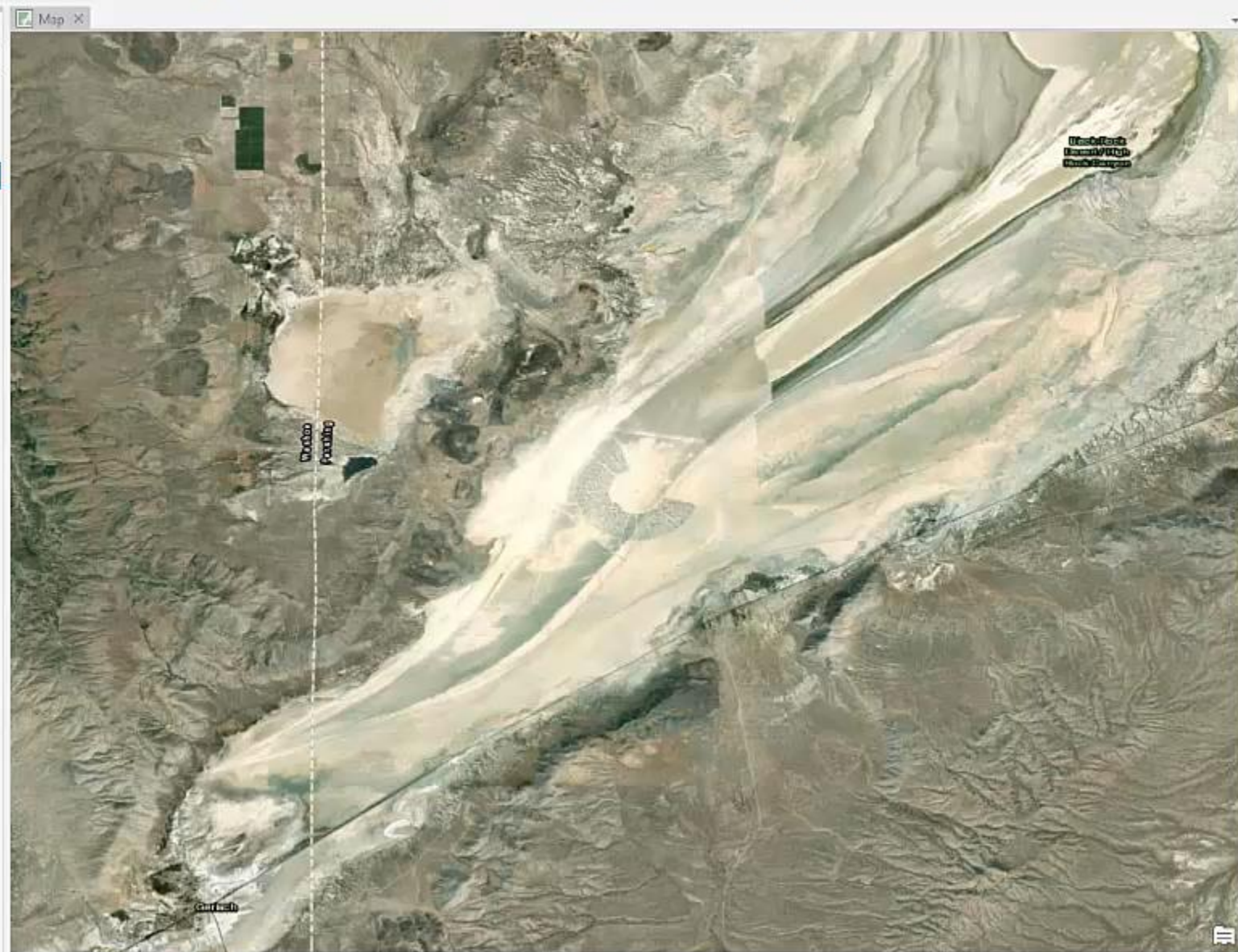
Offline: Download Map, Sync, Remove

Contents

Map

Drawing Order

- Map
- World Boundaries and Places
- World Imagery



Geoprocessing

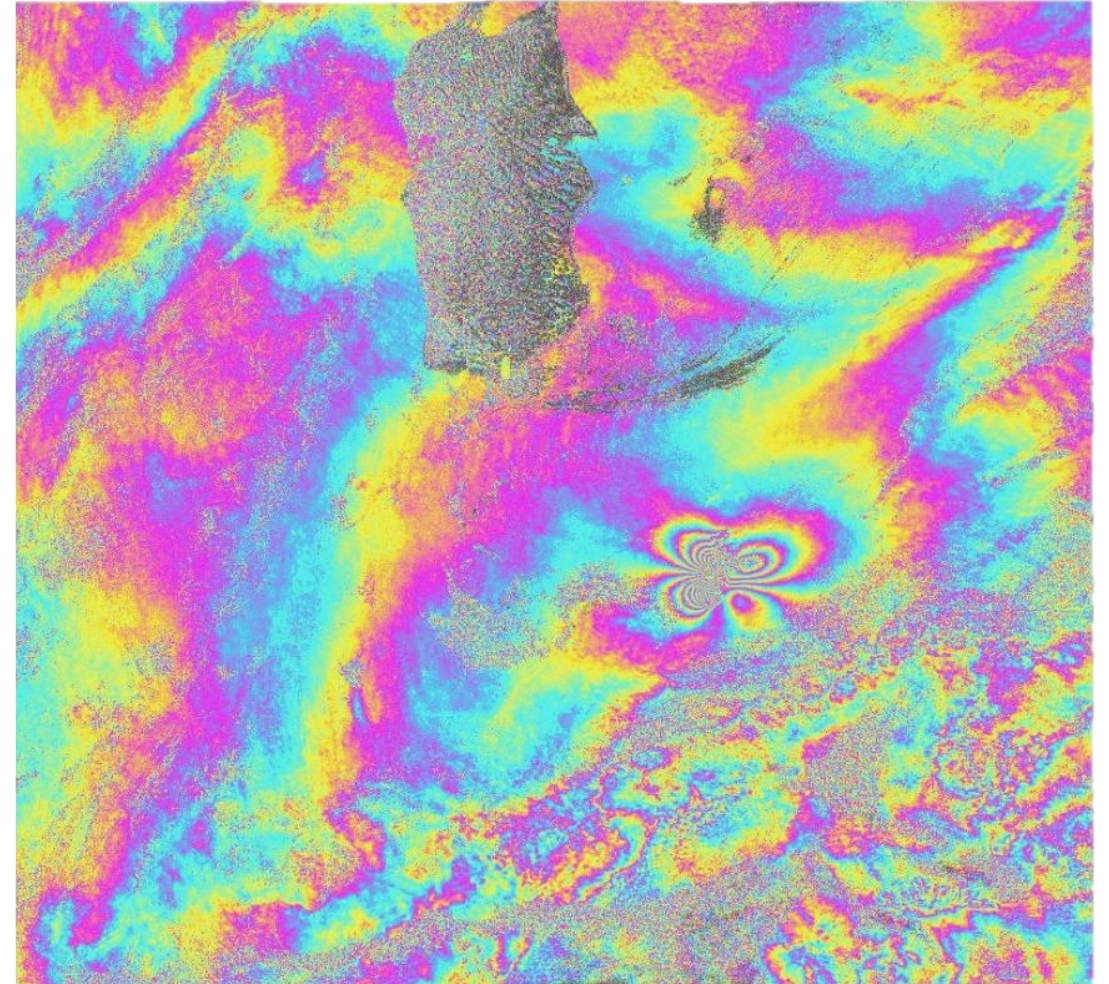
Find Tools

Favorites Toolboxes Portal

- 3D Analyst Tools
- Analysis Tools
- Aviation Tools
- Business Analyst Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Data Reviewer Tools
- Editing Tools
- ENVI Analytics
- ENVI Deep Learning
- ENVI Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Image Analyst Tools
- Linear Referencing Tools
- Location Referencing Tools
- Maritime Tools
- Multidimension Tools
- Network Analyst Tools
- SARscape Analytics**
- SARscape Management Tools
- Server Tools
- Space Time Pattern Mining Tools
- Spatial Analyst Tools
- Spatial Statistics Tools
- Territory Design Tools
- Topographic Production Tools
- Utility Network Tools
- Workflow Manager Tools

Using SAR to Track Movement

- Two methods can be used, Persistent Scatterers (PS) or Small Baseline Subsets (SBAS).
- PS can be used in cases that are showcasing linear behavior, in areas of urban or non-urban regions (such as outcrops) that have persistent reflectors.
- SBAS is used with non-linear behavior (can be modeled as quadratic or cubic) and can be used with lower coherence areas.

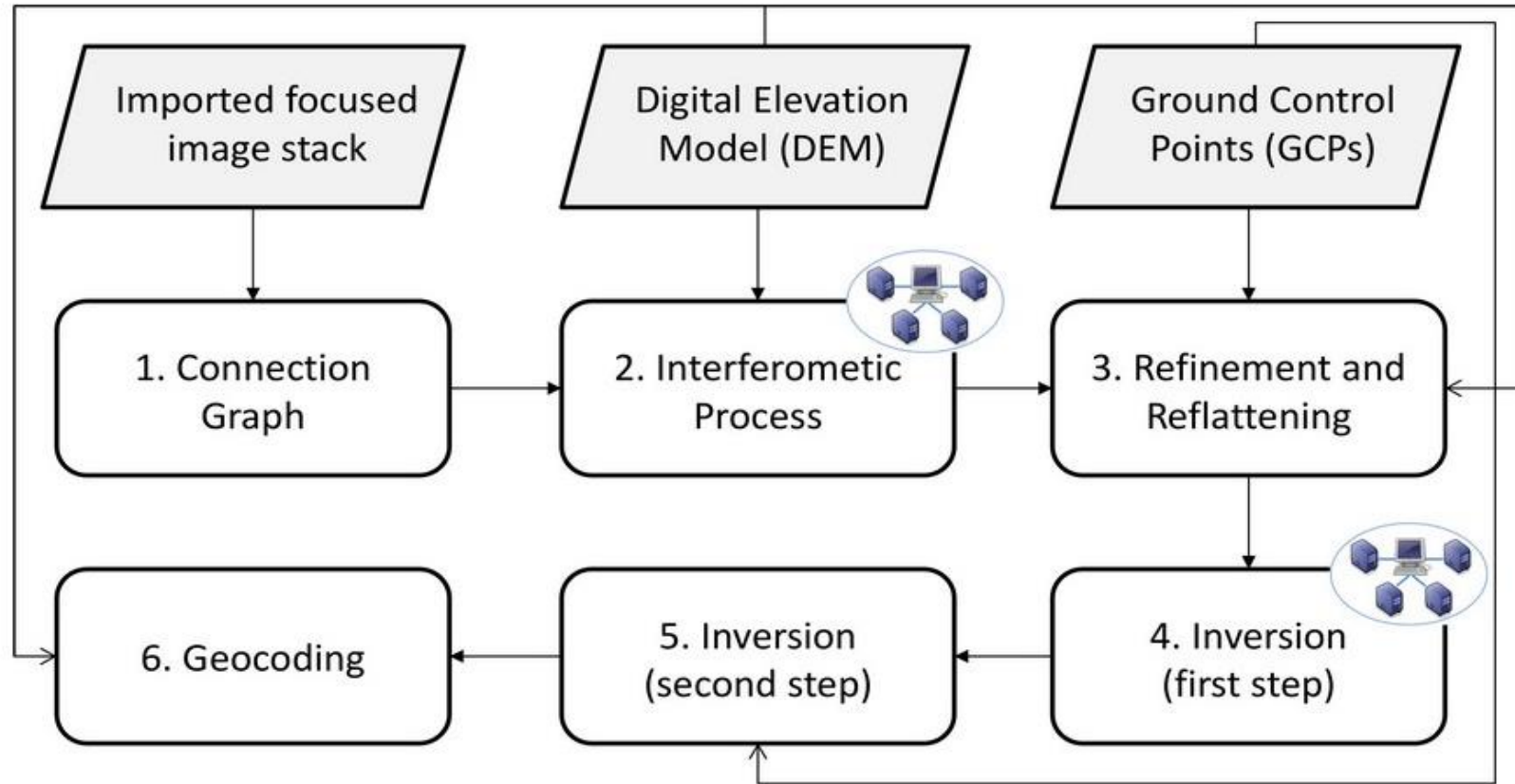


Highway 36 Collapse

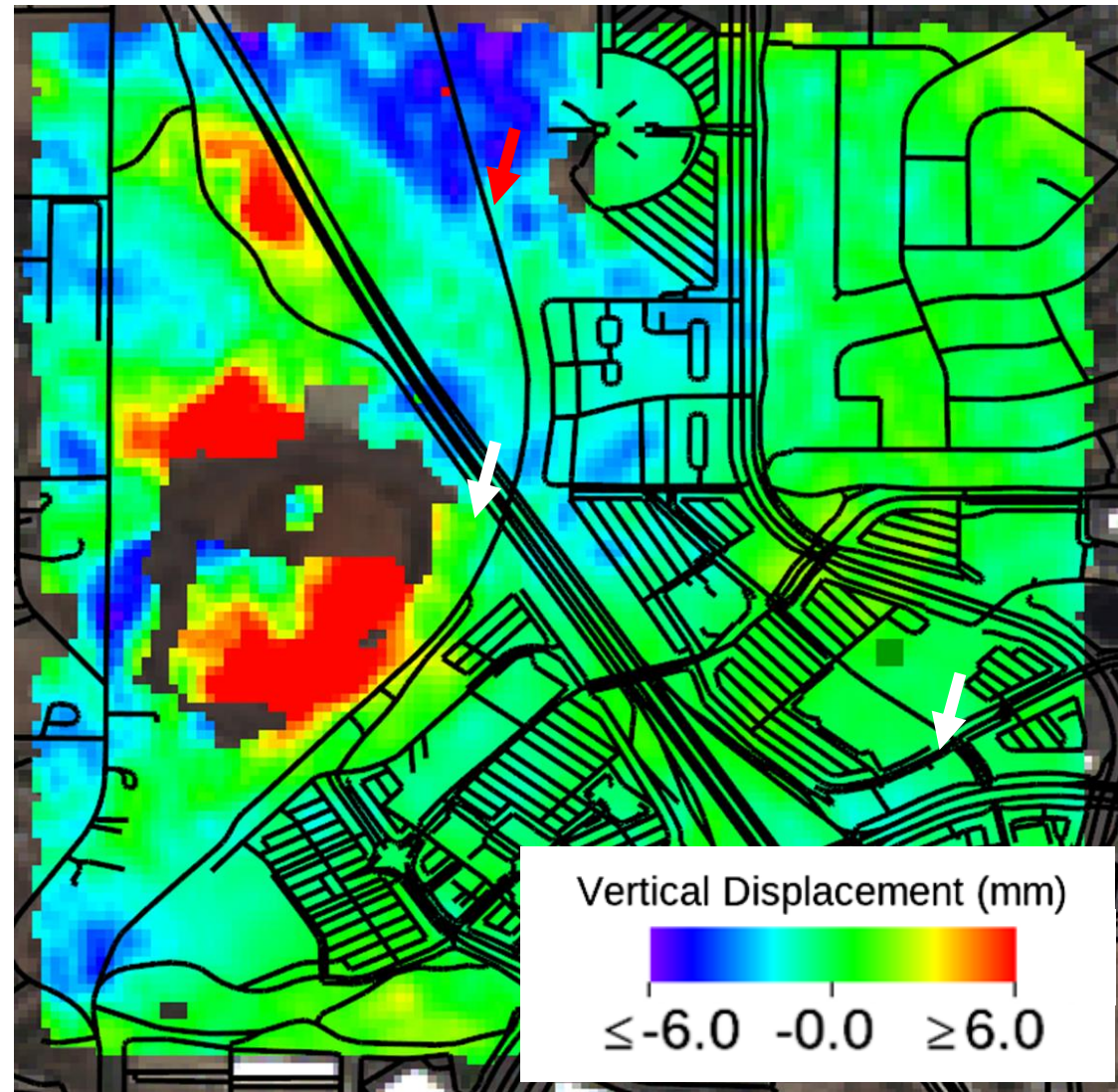
- July 12, 2019, a large crack began to spread across Eastbound lanes of Highway 36 near Church Ranch, Broomfield CO.



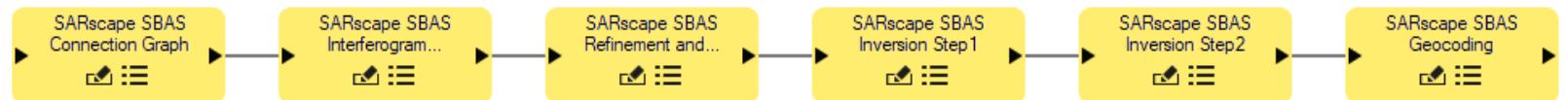
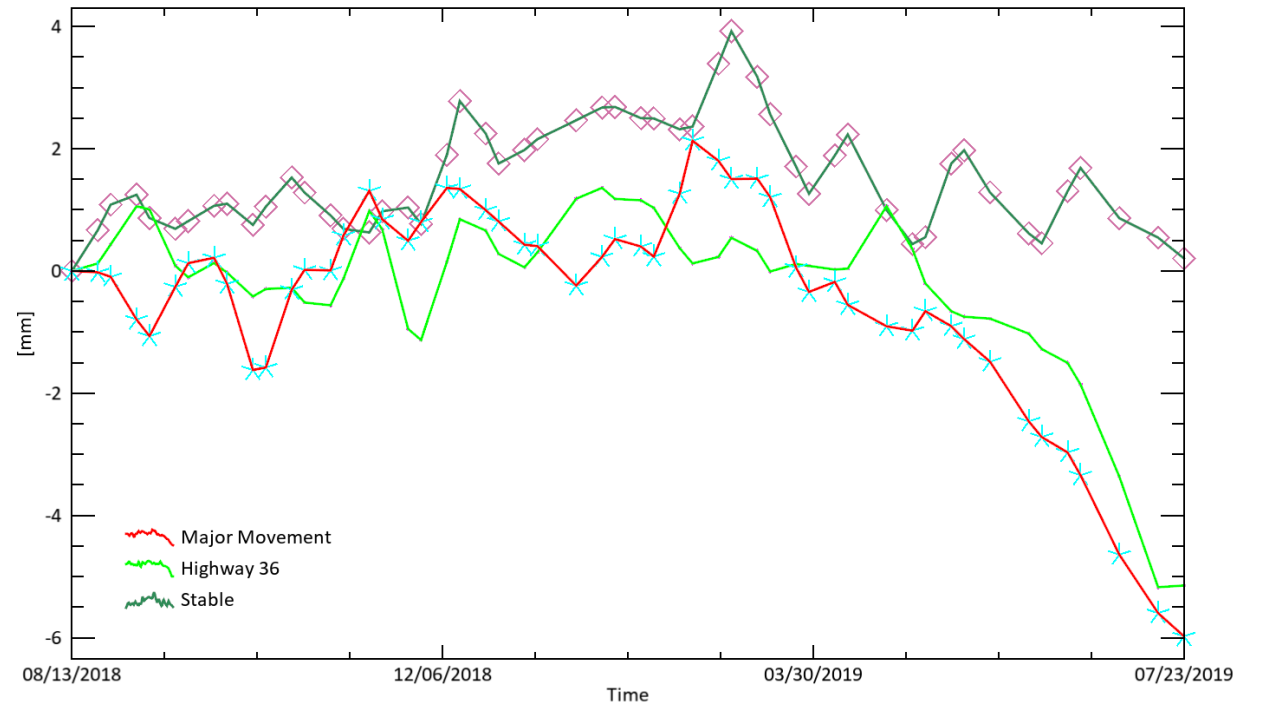
SBAS: Processing



Vertical Movement



Vertical displacement over the region around the Highway 36 collapse.

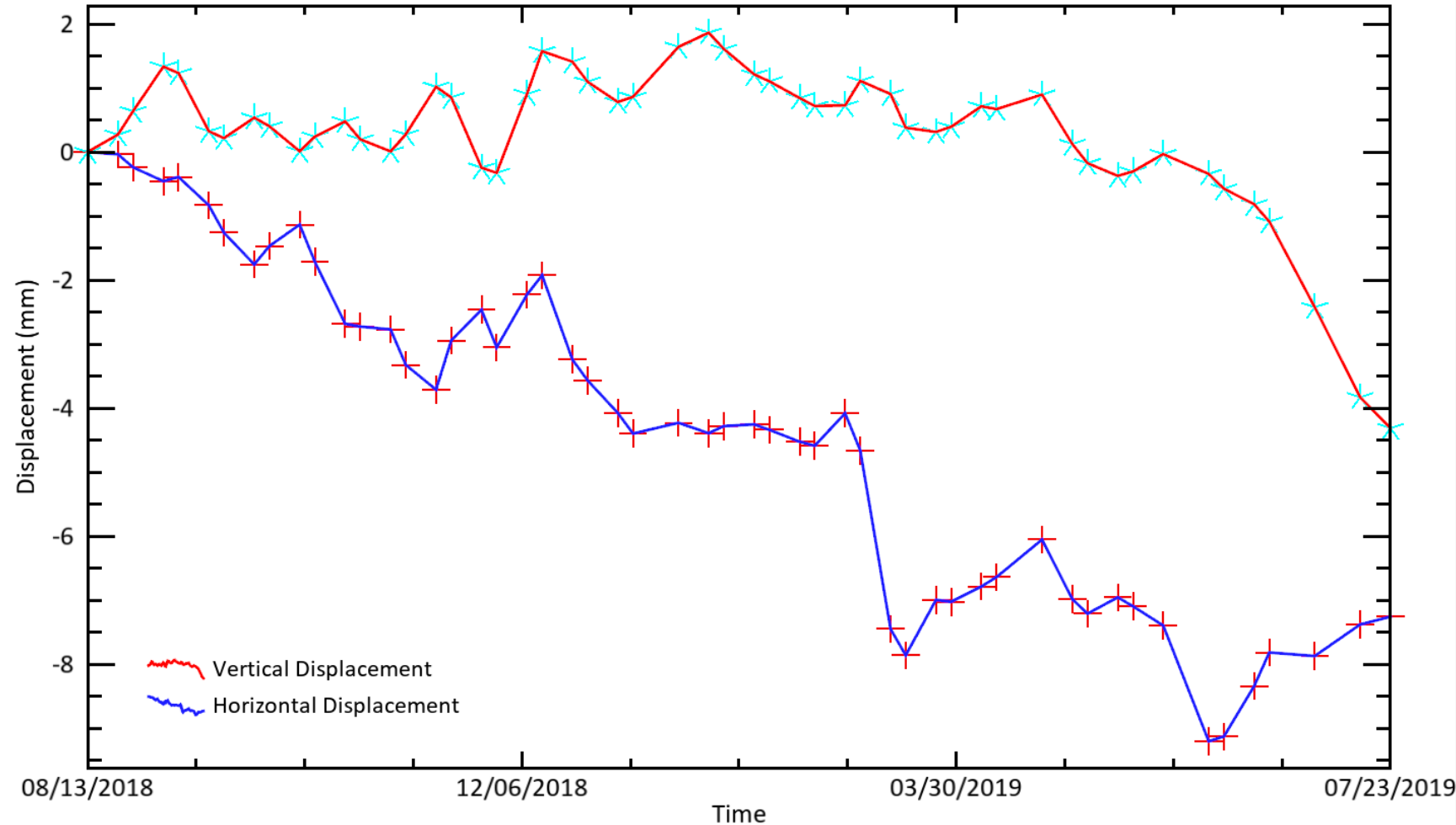


Vertical and Horizontal Movement

Horizontal vs vertical movement have very different stories.

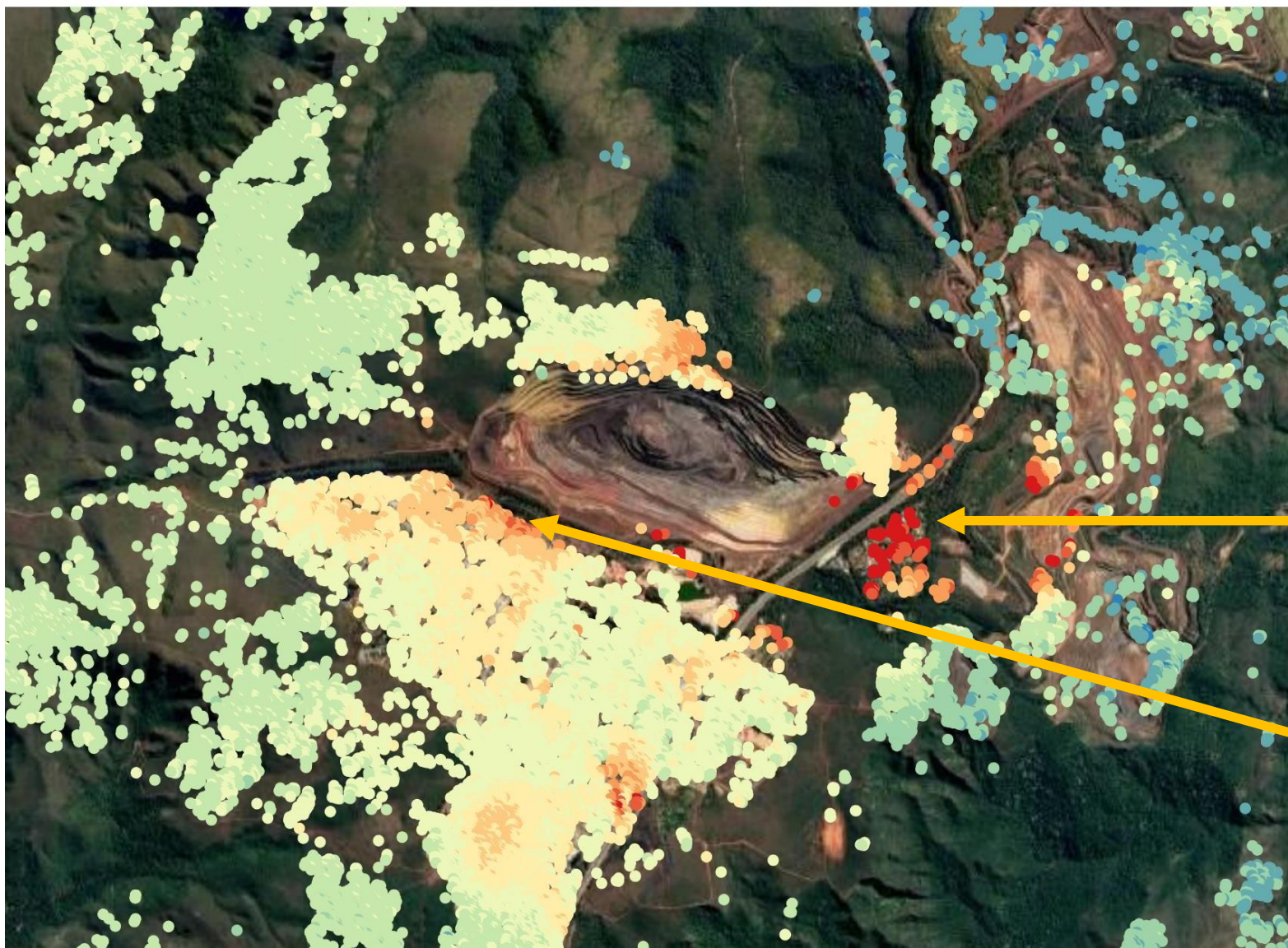
Within the timeline, the area around the highway has been moving towards Church Hill Lake continually. As such we would need a much longer time period to see any major changes.

The vertical movement, however, has an obvious change that occurs around late May (which had over 4 inches of rain) and a sharp decline directly afterwards.



PSI - Mina Mar Azul (Vale)

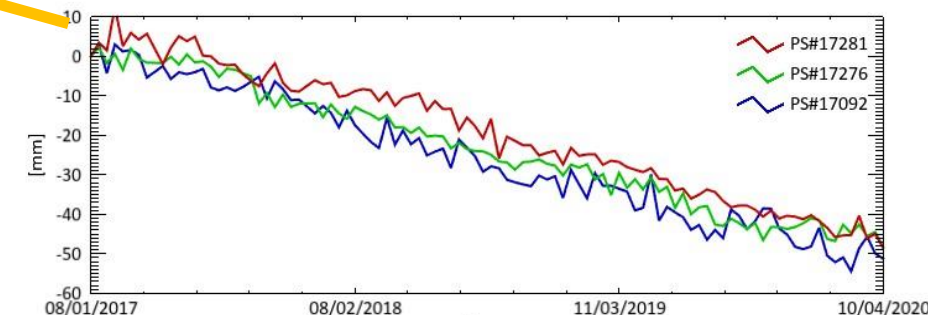
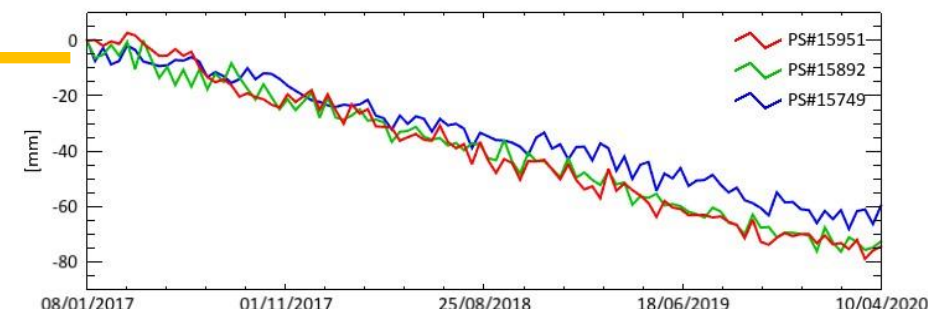
Mina Mar Azul (Vela)



PSI (Jan/2017 - Mar 2020)

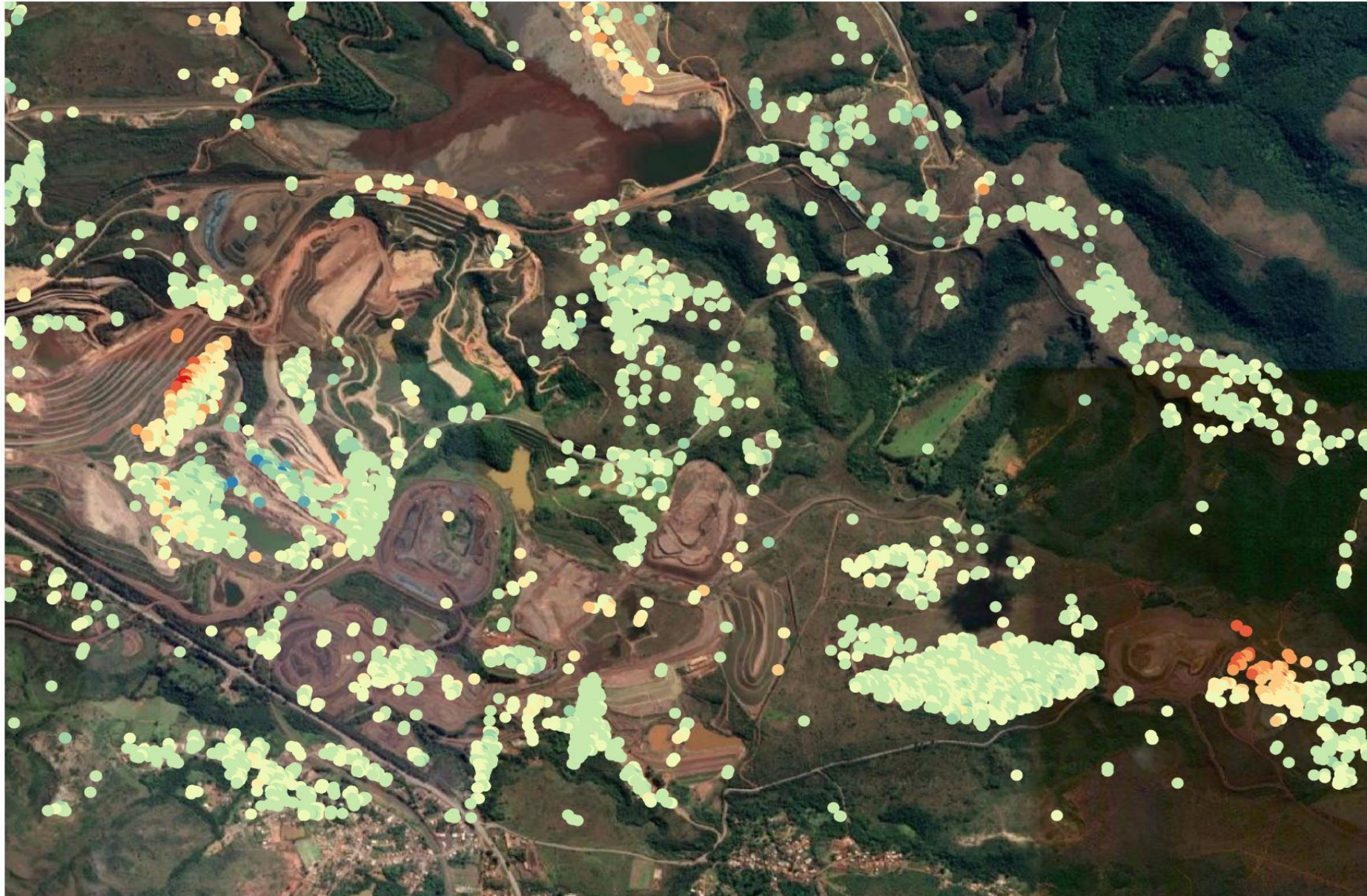
Velocity (mm/year)

- [-24,2 ; -20,1]
- [-20,1 ; -16,1]
- [-16,1 ; -12,0]
- [-12,0 ; -7,90]
- [-7,90 ; -3,90]
- [-3,90 ; 0,20]
- [0,20 ; 4,20]
- [4,20 ; 8,30]
- [8,30 ; 12,4]
- [12,4 ; 16,5]



PSI – Forquilha I

Forquilha I, do Complexo Fábrica (Vale)



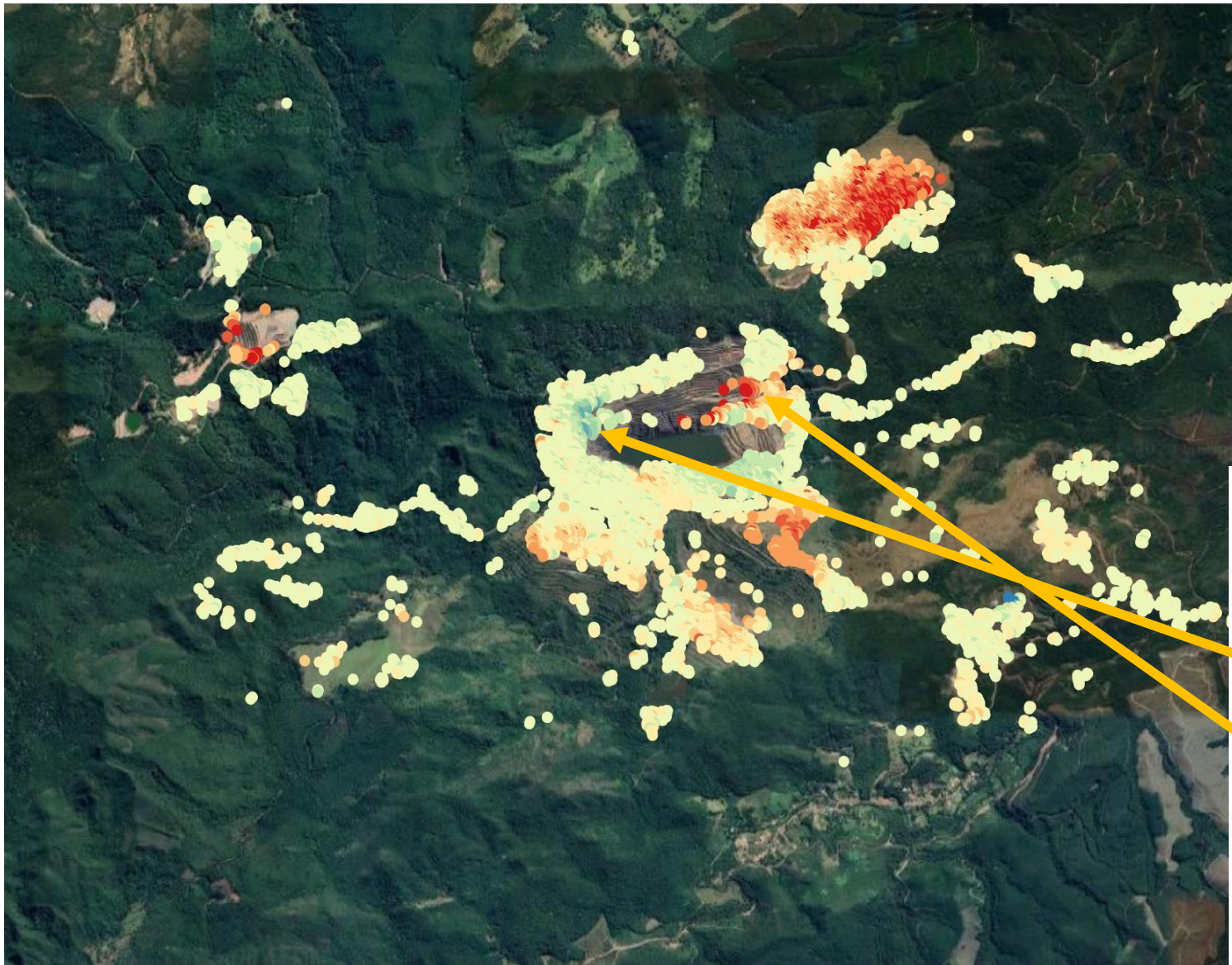
PSI (Jan 2017 - Mar 2020)

Velocity (mm/Year)

- [-19,4 ; -16,3]
- [-16,3 ; -13,3]
- [-13,3 ; -10,2]
- [-10,2 ; -7,1]
- [-7,1 ; -4]
- [-4 ; -1]
- [-1 ; 2,1]
- [2,1 ; 5,2]
- [5,2 ; 8,2]
- [8,2 ; 11,3]

PSI – Mina de Gongo Soco (overview)

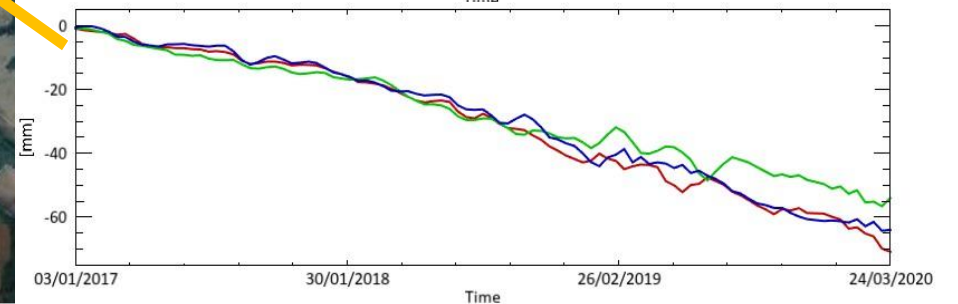
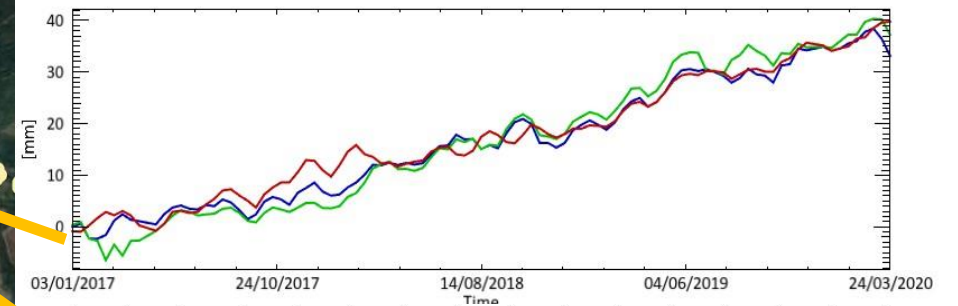
Mina de Gongo Soco



PSI (Jan 2017 - Mar 2020)

Velocity (mm/year)

- [-25 ; -20,5]
- [-20,5 ; -16]
- [-16 ; -11,5]
- [-11,5 ; -7]
- [-7 ; -2,5]
- [-2,5 ; 2]
- [2 ; 6,5]
- [6,5 ; 10,9]
- [10,9 ; 15,4]
- [15,4 ; 19,9]





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